

**Testimony before the Committee on Science, Space, and Technology  
U.S. House of Representatives**

**Hearing on NASA's Aeronautics Mission: Enabling the Transformation of Aviation  
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Madam Chair, Ranking Member Babin, and distinguished Members of the Committee, thank you for the opportunity to testify today. I will focus my remarks on NASA's role in hypersonics research, a field that holds the potential for truly transformative accomplishments in aeronautics.

As I am sure you know, hypersonics is a broad area of inquiry that generally refers to flight in excess of Mach five, or five times the speed of sound – about a mile per second. An airplane flying at hypersonic speeds could travel from Dulles Airport to London Heathrow in less than an hour. Talk about transformative!

We have been flying hypersonic vehicles of one sort or another since the late 1940's, but there are still many fundamental problems left to be solved, especially for vehicles that remain in our atmosphere instead of passing through it on the way to space or back. Propulsion is one – conventional jet engines will not work at hypersonic speeds, and so rockets or "airbreathing" engines such as *scramjets* must be used. At high speeds, friction with the air makes surface temperatures high, stressing the limits of materials. Control of a hypersonic vehicle is also an issue, as is the overall design of an optimized, fully-integrated configuration. NASA has significant expertise in each of these areas.

Historically, NASA aeronautics and even its precursor, the NACA, have made notable contributions to the evolution of hypersonic flight, including our understanding of the physics of reentering spacecraft, traveling in some cases more than 40 times the speed of sound. That work continues today as NASA engineers study the problems associated with decelerating large spacecraft in the thin atmosphere of Mars, and develop new high temperature materials, including the material that will shield SpaceX's Dragon capsule, invented by a team at NASA Ames.

That scramjet engine that I mentioned was invented by NACA researchers working at what is now the NASA Glenn Research Center in the late 1950's. Forty-six years after their work, engineers at NASA Langley and NASA Dryden (now Armstrong) flew the first operational scramjets on the X-43 unmanned aircraft, once at nearly Mach 7, and again at Mach 10. NASA also did key computational and experimental work in support of the Air Force's unmanned X-51 flights between 2010 and 2013. NASA even provided the chase planes that monitored the X-51 craft and gathered essential flight data.

NASA propulsion engineers and materials experts are today playing key roles in several DARPA hypersonic programs, as well as the joint U.S.-Australia HIFiRE flight program. And when engineers at the U.S. Air Force's Hypervelocity Tunnel Number 9 – the nation's premiere

high-speed wind tunnel located in nearby White Oak Maryland – recently needed a new way to measure model temperatures, they turned to their colleagues at NASA Langley.

NASA has developed many of our standard hypersonic aerodynamics models. The agency also operates hypersonic test facilities, including the Langley 8-Foot High Temperature Tunnel, that has gathered data on nearly every significant airbreathing hypersonic engine, including those that powered X-43, X-51, and the upcoming DARPA HAWC designs. The 8-Foot is an irreplaceable national asset – not just the tunnel itself, but the resident knowledge of the NASA test engineers and technicians.

Research in hypersonic flight may someday lead to ultra-fast commercial craft, and maybe even new ways to reach earth orbit with airplane-like launch vehicles; these are wholly appropriate areas for NASA aeronautics research. The proverbial elephant in the room is the likely military use of hypersonics, including ultra-fast, nearly-unstoppable missiles and reconnaissance craft. In 2016 I chaired a National Academies panel that reported that both Russia and China were advancing quickly in the field, and moving to operational deployment. We are in a race, and I believe that NASA *must* help our nation address this threat. I further believe that role is completely consistent with NASA's mission as codified under the Space Act. With knowledge of all aspects of hypersonic flight, from basic physics to test and design, as well as ties to the broader research community, NASA has capabilities in hypersonics that no other federal agency can deploy.

NASA's hypersonics investments began to languish starting in 2012, when a roughly \$60M portfolio was allowed to drop to less than \$10M within two years. More recently NASA's hypersonics funding levels have been on the rise, just as our national programs are hitting limits of capacity and workforce, though they are still at only about half their 2012 levels. NASA's reinvestment has included much-needed maintenance on the Langley 8-foot Tunnel, without which some of our national programs would come to a screeching halt.

That's a promising start, but for our nation to lead the world in hypersonics, we must first create a challenging future vision. The future success of hypersonics ultimately hinges on our ability to integrate computational and experimental capabilities, and NASA is the ideal agency to lead such an effort. World-class research requires world-class researchers who must have access to affordable, flexible world-class modeling and test capabilities. To do this we need to sustain and expand NASA's hypersonic test infrastructure, including the possible recommissioning of the Hypersonic Test Facility at NASA's Ohio Plum Brook campus. And of course, we cannot relinquish our investments in fundamental research, both inside NASA and in the university community that NASA sponsors. With the promise of flying higher and faster, hypersonics is a great way to attract the best and brightest to careers in aerospace.

In conclusion, I am convinced that NASA Aeronautics has a critical role to play in pursuing hypersonics research that will transform our civil, commercial, and national security activities and inspire the next generation. In its mission to transform aviation, I know of no worthier investment in the NASA Aeronautics portfolio.